3.2 **DEFINITIONS**, cont.

Revise or add the following definitions::

Permanent Loads – Loads and forces that are, or are assumed to be, either constant or varying over a long time interval upon completion of construction.

Transient Loads – Loads and forces that are, or are assumed to be, varying over a short time interval or that redistribute under ultimate load.

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3.3.2 Load and Load Designation

Revise as follows:

The following permanent and transient loads and forces shall be considered:

- Permanent Loads

CR = creep
DD = downdrag
DC = dead load of structural components and nonstructural attachments and accumulated locked-in forces that are, or are assumed to be, varying over a short time interval or that redistributes under ultimate load
DW = dead load of wearing surfaces and utilities
EH = horizontal earth pressure load
~~*EL* = accumulated locked-in force effects resulting from the construction process, including the secondary forces from post-tensioning~~
ES = earth surcharge load
EV = vertical pressure from dead load of earth fill
SH = shrinkage

- Transient Loads

BR = vehicular braking force
CE = vehicular centrifugal force
~~*CR* = creep~~
CT = vehicular collision force
CV = vessel collision force
EQ = earthquake
FR = friction
IC = ice load
IM = vehicular dynamic load allowance
LL = vehicular live load
LS = live load surcharge
PL = pedestrian live load
PS = secondary forces from post-tensioning
SE = settlement
~~*SH* = shrinkage~~
TG = temperature gradient
TU = uniform temperature
WA = water load and stream pressure
WL = wind on live load
WS = wind load on structure

3.4.1 Load Factors and Load Combinations

Revise paragraph two, STRENGTH I, as follows:

- STRENGTH I—Basic load combination relating to the normal vehicular use of the bridge without wind. The effects due to 0% channel degradation and 100% channel degradation shall be considered. In addition, the effects due to 100% channel degradation plus 50% local contraction scour shall be considered.

Revise paragraph two, STRENGTH II, as follows:

- STRENGTH II—Load combination relating to the use of the bridge by Owner-specified special design vehicles, evaluation permit vehicles, or both without wind.
  a) DF-- Load combination applies for superstructure design with load **d**istribution **f**actor tables in Articles 4.6.2.2, only.
  b) LVR, SUB-- Load combination used for superstructure design when the lever rule is called for by the tables in Article 4.6.2.2, for substructure design, or whenever a whole number of traffic lanes are to be used. Live loads shall be placed in **a maximum of two** separate lanes chosen to create the most severe conditions.

C3.4.1

Revise paragraph two of Commentary on STRENGTH I as follows:

A reduced value of 0.5, applicable to all strength load combinations, specified for TU, ~~CR, and SH~~ used when calculating force effect~~s~~ other than displacements at the strength limit state, represents an expected reduction of ~~these~~ this force effects in conjunction with the inelastic response of the structure. The calculation of displacements for ~~these~~ this load~~s~~ utilizes….

Revise paragraph two of Commentary on STRENGTH II as follows:

~~The permit vehicle should not be assumed to be the only vehicle on the bridge unless so assured by traffic control. See Article 4.6.2.2.4 regarding other traffic on the bridge simultaneously~~. Caltrans presently does not use the vehicular braking force in this load combination.

a) DF--Multiple presence is already considered in the load distribution factor tables in Articles 4.6.2.2.
b) LVR, SUB--Multiple presence factors from Article 3.6.1.1.2 apply.

Revise paragraph nine of Commentary on EXTREME II as follows:

The joint probability of these events is extremely low, and, therefore, the events are specified to be applied separately. Under these extreme conditions, the structure is expected to undergo considerable inelastic deformation by which locked-in-force effects due to TU, TG, ~~CR, SH~~ and SE are expected to be relieved.

(3.4.1, cont.)
Revise paragraph six as follows:

The larger of the two values provided for load factors of *TU*, ~~*CR*, and *SH*~~ shall be used for deformations and the smaller values for all other effects. The larger γ_p factors for *CR* and *SH* shall also be used for deformations.

Revise Equation 3.4.1-2 as follows:
$DC+DW+EH+EV+ES+WA+CR+SH+TG+\cancel{EL+}PS$

3.4.1

Revise Table 3.4.1-1 as follows:

Load Combination Limit State	DC DD DW ~~EL~~ EH EV ES **PS** **CR** **SH**	HL93 IM CE BR PL LS	Permit IM CE	WA	WS	WL	FR	TU ~~CR~~ ~~SH~~	TG	SE	EQ IC CT CV (use only one)
STRENGTH I	γ_p	1.75	**0.0**	1.0	**0.0**	**0.0**	1.0	0.50/ 1.20	γ_{TG}	γ_{SE}	**0.0**
STRENGTH II- DF, LVR,SUB	γ_p	**0.0**	1.35	1.0	**0.0**	**0.0**	1.0	0.50/ 1.20	γ_{TG}	γ_{SE}	**0.0**
STRENGTH III	γ_p	**0.0**	**0.0**	1.0	1.4	**0.0**	1.0	0.50/ 1.20	γ_{TG}	γ_{SE}	**0.0**
STRENGTH IV EH, EV,EL ES, DW, DD DC only	γ_p 1.5	**0.0**	**0.0**	1.0	**0.0**	**0.0**	1.0	0.50/ 1.20	**0.0**	**0.0**	**0.0**
STRENGTH V	γ_p	1.35	**0.0**	1.0	0.4	1.0	1.0	0.50/ 1.20	γ_{TG}	γ_{SE}	**0.0**
EXTREME EVENT I	~~γ_p~~ **1.0**	~~γ_{EQ}~~ **0.0**	**0.0**	1.0	**0.0**	**0.0**	1.0	**0.0**	**0.0**	**0.0**	1.00 (EQ)
EXTREME EVENT II	~~γ_p~~ **1.0**	0.5	**0.0**	1.0	**0.0**	**0.0**	1.0	**0.0**	**0.0**	**0.0**	1.00 (IC or CT or CV)
SERVICE I	1.00	1.00	**0.00**	1.00	0.30	1.0	1.0	1.00/ 1.20	γ_{TG}	γ_{SE}	**0.0**
SERVICE II	1.00	1.30	**0.00**	1.00	**0.0**	**0.0**	1.0	1.00/ 1.20	**0.0**	**0.0**	**0.0**
SERVICE III	1.00	0.80	**0.00**	1.00	**0.0**	**0.0**	1.0	1.00/ 1.20	γ_{TG}	γ_{SE}	**0.0**
SERVICE IV	1.00	**0.00**	**0.00**	1.00	0.70	**0.0**	1.0	1.00/ 1.20	**0.0**	1.0	**0.0**
FATIGUE I—	**0.00**	0.75	**0.00**	**0.00**	**0.00**	**0.0**	**0.0**	**0.00**	**0.0**	**0.0**	**0.00**
FATIGUE II?		1.50?									
FATIGUE III?			**(P9 truck?)**								

Table 3.4.1-1 – Load Combinations and Load Factors

Modify Table 3.4.1-1 as follows:

Table 3.4.1-2 (excerpts) Type of Load	Load Factor	
	Maximum	Minimum
DC: Component and Attachments; **CR, SH**	1.25	0.90
~~***EL*: Locked-in Erection Stresses**~~ **PS: Secondary Force from Post-Tensioning**	1.00	1.00

3.4.1 (cont.)

Delete paragraph 13:

~~The load factor for live load in Extreme Event Load Combination I,~~ $\cancel{\gamma_{EQ}}$, ~~shall be determined on a project-by-project basis"~~

3.5 PERMANENT LOADS

Revise as follows:

3.5.1 Dead Loads: *DC, DW*~~, and~~ *EV* *CR and SH*

Dead load shall include the weight of all components of the structure, appurtenances and utilities attached thereto, earth cover, wearing surface, future overlays, and planned widenings.

Where appropriate, differential shrinkage strains between concretes of different age and composition, and between concrete and steel or wood, shall be determined in accordance with the provisions of Section 5.

Creep strains for concrete and wood shall be in accordance with the provisions of Section 5 and Section 8, respectively. In determining force effects and deformations due to creep, dependence on time and changes in compressive stresses shall be taken into account.

In the absence of more precise information, the unit weights, specified in Table 1, may be used for dead loads.

C3.5.1

The Designer may specify timing and sequence of construction in order to minimize stresses due to differential shrinkage between components.

Traditionally, only creep of concrete is considered. Creep of wood is addressed only because it applies to prestressed wood decks.

Table 1 provides….(*remainder of Commentary remains unchanged*)

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3.6.1.1.2 Multiple Presence of Live Load

Revise paragraph three as follows:

The factors specified in Table 1 shall not be applied in conjunction with approximate load distribution factors specified in Articles 4.6.2.2 and 4.6.2.3, except where the lever rule is used or where special requirements for exterior beams in beam-slab bridges, specified in Article 4.6.2.2.2d, are used. Furthermore, the factors specified in Table 1 shall not be applied to the design of culvert top slabs when using the equivalent strip method as specified in Article 4.6.2.1.

C3.6.1.1.2

Revise paragraph three as follows:

Reinforced Box Culverts are designed on a unit-width basis. Each unit-width must be capable of withstanding the applied truck load regardless of how many adjacent lanes are loaded. Furthermore, live load forces overlap but dissipate through the fill, and generally are less significant than loads due to fill.

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Distribution of Wheel Loads Through Earth Fills

Revise paragraph two as follows:

In lieu of a more precise analysis, or the use of other acceptable approximate methods of load distribution permitted in Section 12, where the depth of fill is 2.0 ft. or greater, wheel loads may be considered to be uniformly distributed over a rectangular area with sides equal to the dimension of the tire contact area, as specified in Article 3.6.1.2.5, and increased by ~~either 1.15 times the depth of the fill in select granular backfill, or~~ the depth of the fill in all other cases. The provisions of Articles~~ 3.6.1.1.2 and~~ 3.6.1.3 shall apply.

C3.6.1.2.6

Add paragraphs three and four as follows:

Caltrans does not use "select granular backfill" for its embankments.

Caltrans does not apply the multiple presence factor when designing the top slab of culverts.

3.6.1.3.1

Add a 4th bullet as follows:

- For both negative moment between points of contraflexure under a uniform load on all spans, and reaction at interior piers only, 100 percent of the effect of two design tandems spaced anywhere from 26.0 ft. to 40 ft. from the lead axle of one tandem to the rear axle of the other, combined with the design lane load specified in Article 3.6.1.2.4.

C3.6.1.3.1

Revise paragraph three as follows:

The notional design loads were based on the information described in Article C3.6.1.2.1, which contained data on "low boy" type vehicles weighing up to about 110 kip. ~~Where multiple lanes of heavier versions of this type of vehicle are considered probable, consideration should be given to investigating negative moment and reactions at interior supports for pairs of the design tandem spaced from 26.0 ft. to 40.0 ft. apart, combined with the design lane load specified in Article 3.6.1.2.4. One hundred percent of the combined effect of the design tandems and the design lane load should be used.~~ In California, side-by-side occurrences of the "low boy" truck configuration are routinely found. This amendment is consistent with Article 3.6.1.2.1, will control negative bending serviceability in two-span continuous structures with 20- to 60-ft span lengths, and should not be considered a replacement for the Strength II Load Combination.

3.6.1.3.3 *Design Loads for Decks, Deck Systems, and the Top Slabs of Box Culverts*

C3.6.1.3.3

Add paragraph four as follows:

The force effects due to one 32-k axle on the strip-widths specified in Table 4.6.2.1.3-1, were found to be similar to Caltrans' past practice and envelop two 24-k axles 4-0 o.c. (design tandem). Also, the 54-k tandem axle of the permit vehicle typically doesn't control deck designs when applying the appropriate load factors or allowable stresses. The 2005 Interims clarified that the lane load is not used in deck design.

3.6.1.3.4 Deck Overhang Load

Delete paragraph one.

~~For the design of deck overhangs with a cantilever, not exceeding 6.0 ft. from the centerline of the exterior girder to the face of a structurally continuous concrete railing, the outside row of wheel loads may be replaced with a uniformly distributed line load of 1.0 klf intensity, located 1.0 ft. from the face of the railing.~~

C3.6.1.3.4

Add as paragraph two

Caltrans barriers are not considered as continuous structural elements.

3.6.1.4 Fatigue Load

Revisions pending

3.6.1.6 Pedestrian Loads

Revise paragraph one as follows:

See the provisions of Article 3.6.1.1.2 for applying the pedestrian loads in combination with the vehicular live load. The pedestrian load need not be used in the Strength II load combination.

Add paragraph four as follows:

The frequency of pedestrian footfall loads in either the vertical or transverse lateral direction shall not resonate with the natural frequencies of the structure.

Add paragraph four as follows:

Footfall has been estimated to have a frequency of 2 Hz in the vertical direction, and 0.67 Hz in the transverse lateral direction. Therefore, the fundamental frequency of the structure should be a minimum of 3 HZ and 1.3 Hz in the vertical and lateral directions respectively, unless detailed analysis justifies otherwise.

Add a new Article as follows:

3.6.1.8 Permit Vehicles

3.6.1.8.1 General

Permit design live loads, or P loads, are special design vehicular loads. The weights and spacings of axles and wheels for the overload truck shall be as specified in Figure 3.6.1.8.1-1.

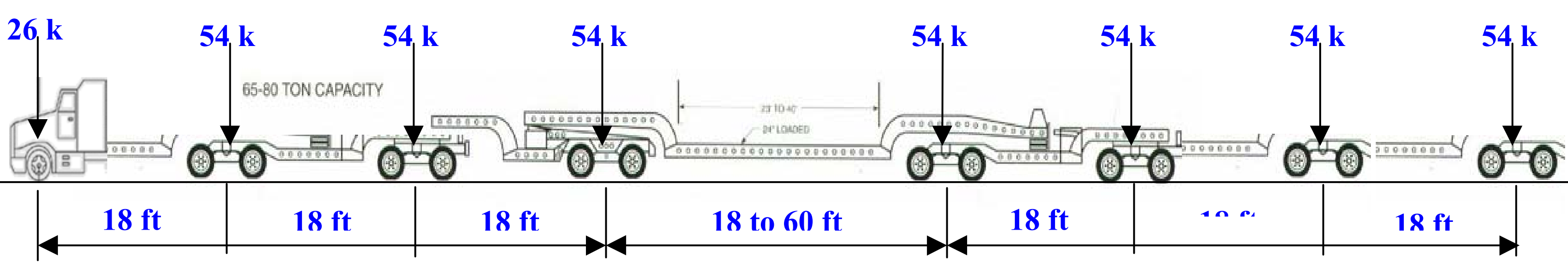

Figure 3.6.1.8.1-1 California P15 truck

3.6.1.8.2. Application

The permit design live loads shall be applied in combination with other loads as specified in Article 3.4.1. Axles that do not contribute to the extreme force effect under consideration shall be neglected.

Dynamic load allowance shall be applied as specified in 3.6.2.

Multiple presence factors shall be applied as specifed in Article 3.6.1.1.2. However, when only one lane of permit is being considered, the MPF for one loaded lane shall be 1.0.

3.6.2 Dynamic Load Allowance: IM
3.6.2.1 General

Revise paragraph as follows:

Unless otherwise permitted in Articles 3.6.2.2 and 3.6.2.3, the static effects of the design truck, ~~or~~ design tandem, or permit vehicle other than centrifugal and braking forces….

Revise Table 3.6.2.1-1 as follows:

Component	*IM*
Deck Joints—All Limit States	75%
All Other Components	
• Fatigue and Fracture Limit State	15%
• Strength II Limit State	25%
• All Other Limit States	33%

C3.6.2.1

Revise paragraphs four and five as follows:

Field tests indicate that in the majority of highway bridges, the dynamic component of the response does not exceed 25 percent of the static response to vehicles. This is the basis for dynamic load allowance with the exception of deck joints. However, the specified live load combination of the design truck and lane load, represents a group of exclusion vehicles that are at least 4/3 of those caused by the design truck alone on short- and medium-span bridges. The specified value of 33 percent in Table 1 is the product of 4/3 and the basic 25 percent. California removed the 4/3 factor for Strength II because a lane load isn't a part of the design permit vehicle used. Furthermore, force effects due to shorter permit vehicles approach those due to the HL93. The HL93 tandem*1.33 + lane generally has a greater force effect than that due to the P15 on short-span bridges.

Generally speaking, the dynamic amplification of trucks follows the following general trends:

- As the weight of the vehicle goes up, the apparent amplification goes down.
- Multiple vehicles produce a lower dynamic amplification than a single vehicle.
- More axles result in a lower dynamic amplification.

~~For heavy permit vehicles which have many axles compared to the design truck, a reduction in the dynamic load allowance may be warranted.~~ A study of dynamic effects presented in a report by the Calibration Task Group (*Nowak 1992*) contains details regarding the relationship between dynamic load allowance and vehicle configuration.

3.6.3 Centrifugal Forces: CE

Revise paragraphs one and two as follows:

Centrifugal forces shall be taken as the product of the axle weights of the design truck, ~~or~~ design tandem, or permit vehicle and the factor C, taken as....

Highway design speed shall not be taken to be less than the value specified in AASHTO publication *A policy of Geometric Design of highways and Streets (1990),* the Caltrans Highway Design Manual (current edition), or as otherwise directed. The design speed for permit vehicles shall be 25 mph, maximum.

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Delete Article 3.6.5.2 and Commentary

3.6.5.2 Vehicle and Railway Collision with Structures

~~Unless protected as specified in Article 3.6.5.1, abutments and piers located within a distance of 30.0 ft. to the edge of roadway, or within a distance of 50.0 ft. to the centerline of a railway track, shall be designed for an equivalent static force of 400 kip, which is assumed to act in any direction in a horizontal plane, at a distance of 4.0 ft. above ground.~~

~~The provisions of Article 2.3.2.2.1 shall apply.~~

C3.6.5.2

~~It is not the intent of this provision to encourage unprotected piers and abutments within the setbacks indicated, but rather to supply some guidance for structural design when it is deemed totally impractical to meet the requirements of Article 3.6.5.1.~~

~~The equivalent static force of 400 kip is based on the information from full-scale crash tests of barriers for redirecting 80.0 kip tractor trailers and from analysis of other truck collisions. The 400 kip train collision load is based on recent, physically unverified, analytical work (*Hirsch 1989*). For individual column shafts, the 400 kip load should be considered a point load. For wall piers, the load may be considered to be a point load or may be distributed over an area deemed suitable for the size of the structure and the anticipated impacting vehicle, but not greater than 5.0 ft. wide by 2.0 ft. high. These dimensions were determined by considering the size of a truck frame.~~

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3.7.5 Change in Foundations Due to Limit State for Scour

Revise paragraph two as follows:

The consequences of changes in foundation conditions resulting from the design and base ~~and check~~ floods ~~for scour~~ shall be considered as specified in Section 2 and Article 3.4.1 of the Specifications and California Amendments ~~at strength and service limit states. The consequences of changes in foundation conditions due to scour resulting from the check flood for bridge scour and from hurricanes shall be considered at the extreme event limit states.~~

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3.12 FORCE EFFECTS DUE TO SUPERIMPOSED DEFORMATIONS: *TU*, *TG*, ~~*SH*, *CR*~~, *SE*

3.12.4 Differential Shrinkage

Deleted (content moved to Article 3.5.1)

3.12.5 Creep

Deleted (content moved to Article 3.5.1)

C3.12.4 Deleted (content moved to Article C3.5.1)

C3.12.5 Deleted (content moved to Article C3.5.1)

SPECIFICATIONS

COMMENTARY

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